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Shot Boundary Detection using Radon Projection Method

Parul S. Arora Bhalotra[1], Bhushan D. Patil[2]
[1] Research Scholar, J.J.T.University, G.H.R.C.E.M, Pune, India.
Email: parulsarora@gmail.com
[2] Samsung Research India, Bangalore, Email: bhushandpatil@gmail.com

***Abstract*—The detection of shot boundaries provides a base for nearly all video abstraction and high-level video segmentation approaches. Therefore solving the problem of shot boundary detection is one of the major prerequisites for revealing higher level video content structure. As a crucial step in video indexing and retrieval, accurate shot boundary detection plays an important role to organize and summarize video content into meaningful shots for further scene analysis. Many algorithms have been proposed for detecting video shot boundaries and classifying shots and shot transition types. In this paper we propose a novel technique for shot boundary detection using radon transform. We first removed the effect of illumination using DCT and DWT. Then shot boundary is detected using radon transform. Radon transform is based on projection of image intensity along a radial line oriented at a specific angle. Projection of image intensity for current frame is different than that of projection of the previous frame, where shot boundary is detected. In order to verify the performance of algorithm, experiments have been carried out with news, documentary and movie. Experimental result demonstrates efficiency of proposed shot boundary detection technique.**

***Index Terms*—Video shot boundary detection, DCT, DWT, Radon projection.**

I. Introduction

Video shot boundary detection has been deeply studied in recent years and has found applications in different domains like video indexing, video compression, video access. Advances in digital technology have made many video archives readily available. Therefore scalable and effective tools for indexing and retrieving video are needed. With a large amount of information encoded in one video, typically the first step of any video processing tools is to segment the input video into elementary shots in which each shot is defined as a continuous frame from a single camera at a given moment. The detection of shot boundaries provides a base for nearly all video abstraction and high-level video segmentation approaches. Therefore solving the problem of shot boundary detection is one of the major prerequisites for revealing higher level video content structure. Depending on transition between the shots, the shot boundaries can be categorized into two types: abrupt transition and gradual transition. The gradual transition can be further classiûed into dissolve, wipe, fade in and fade out, according to the characteristics of the different editing effects. The existing methods on shot boundary detection are discussed below.

Likelihood ratio, pair-wise comparison and histogram comparison have been used as a different metric for shot boundary detection by Zhang et al. [1].Object motion and camera motion have been observed as major source of false positives by Boreczky and Lawrence [2]. They presented a comparison of several shot boundary detection classification techniques and their variations including pixel difference, statistical difference, compression difference Histogram, Edge tracking, discrete cosine transform, motion vector and block matching methods. It was seen that algorithm features that seemed to produce good results were region based comparisons, running differences and motion vector analysis. According to Boreczky combination of these three features may perform well to produce better results than either the region histogram or running histogram algorithm. Lienhart [3] has used color histogram differences. Standard deviation of pixel intensities and edge based contrast as a metric to find shot boundaries and tested results on diverse set of video sequences. Henjalic [4] have identified and analyzed the major issues related to shot boundary detection in detail. Knowledge relevant to shot boundary detection, shot length distribution, visual discontinuity pattern at shot boundaries and characteristic temporal changes of visual features around a boundary are needed to be considered for the study.

Gargi et al. [5] have evaluated and characterized the performance of number of shot detection methods using color histogram, moving picture expert group compression parameter information and image block motion matching. Ford et al. [6] have reported results on various histogram test statistics, pixel difference. Yuan et al. [7] have presented a comprehensive review of existing approaches and identified major challenges to shot boundary detection, according to them elimination of disturbances due to motion of large object and camera is a challenge in shot boundary detection. Sethi and Patel [8] have tested statistical test for changes in scene. Jinhui yuan et al. [9] employed three critical techniques i.e representation of visual content, construction of continuity signal and classification of continuity values are identified and formulated in the perspective of pattern recognition. The methods of classification are rule based classifiers and statistical machine learning. Module evaluation and system evaluation was done. For module evaluation the specific module varies in different approaches while the other module of the system retains the same implementation. The three mappings identified by the formal framework are research problem for pattern recognition, which have undergone relatively mature evolution.

In the proposed algorithm illumination change is removed using discrete cosine transform and discrete wavelet

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transform followed by detection of shot boundaries by applying the techniques of finding difference by conventional method i.e. normal difference and by wavelet method.

The rest of the paper is organized as follows, Section II describes Radon transform details. We discuss results and conclude the paper in section III and section IV.

II. Radon Transformation

In recent years the Radon transform have received much attention. This transform is able to transform two dimensional images with lines into a domain of possible line parameters, where each line in the image will give a peak positioned at the corresponding line parameters. This have lead to many line detection applications within image processing, computer vision, and seismic [10][11].

The Radon Transformation is a fundamental tool which is used in various applications such as radar imaging, geophysical imaging, nondestructive testing and medical imaging [12]. The Radon transform computes projections of an image matrix along specified directions. A projection of a two-dimensional function f(x, y) is a set of line integrals.

The Radon function computes the line integrals from multiple sources along parallel paths, or beams, in a certain direction. The beams are spaced 1 pixel unit apart.

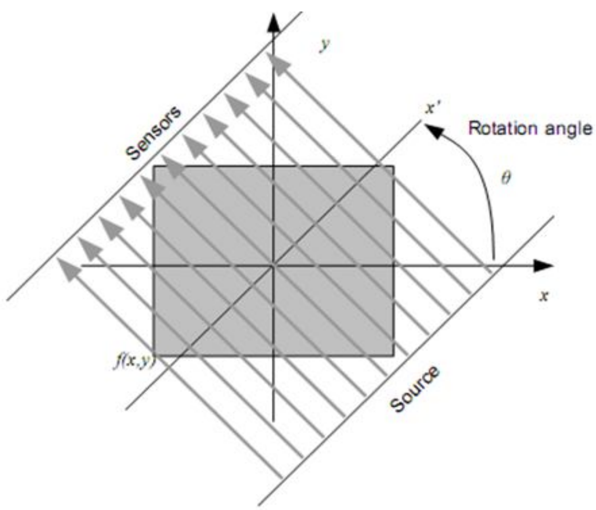

Fig 1. Single projection at a specified rotation angle

To represent an image radon function takes multiple, parallel-beam projections of the image from different angles by rotating the source around the centre of the image. The Fig.1 shows a single projection at a specified rotation angle. The Radon transform is the projection of the image intensity along a radial line oriented at a specific angle. The radial coordinates are the values along the x'-axis, which is oriented at θ degrees counter clockwise from the x-axis.

The origin of both axes is the center pixel of the image. For example, the line integral of f(x, y) in the vertical direction is the projection of f(x, y) onto the x-axis; the line integral in the horizontal direction is the projection of f(x, y) onto the y axis.

The Fig.2 shows horizontal and vertical projections for a simple two-dimensional function.

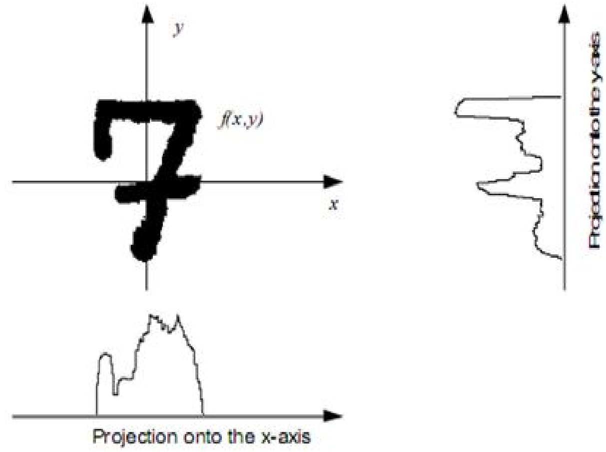

Fig 2. Horizontal and vertical projection of simple function

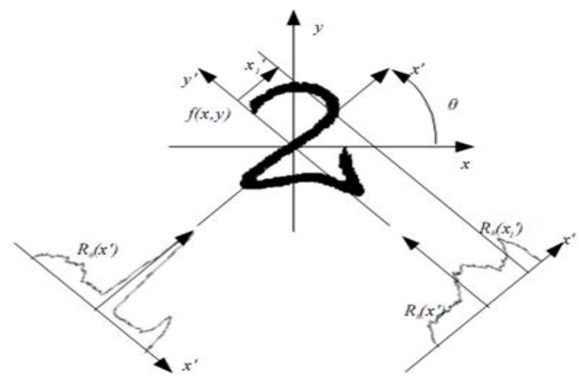

Fig 3.Geometry of the Radon Transform

Projections can be computed along any angle θ, by use general equation of the Radon transformation [Asano (2002)[13][14][15]:

$$R_\theta(x') = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} f(x,y)\delta(x\cos\theta + y\sin\theta - x')dxdy \quad (1)$$

where δ (‡) is the delta function with value not equal zero only for argument equal 0, and:

$$x' = x\cos\theta - y\sin\theta \quad (2)$$

x' is the perpendicular distance of the beam from the origin and θ is the angle of incidence of the beams. The Fig.3 illustrates the geometry of the Radon Transformation. The very strong property of the Radon transform is the ability to extract lines (curves in general) from very noise images. Radon transform has some interesting properties relating to the application of affine transformations. We can compute the Radon transform of any translated, rotated or scaled image, knowing the Radon transform of the original image and the parameters of the affine transformation applied to it.

This is a very interesting property for symbol representation because it permits to distinguish between transformed objects, but we can also know if two objects are related by an affine transformation by analyzing their Radon transforms [16] as shown in Fig.4. It is also possible to generalize the Radon transform in order to detect parameterized curves with non-linear behavior [10][17][18]. The 2D discrete Radon transform is defined by

$$R(k,\theta) = \sum_{x=0}^{N-1}\sum_{y=0}^{N-1} I(x,y)\delta(k - xy_\theta + yx_\theta) \quad (3)$$

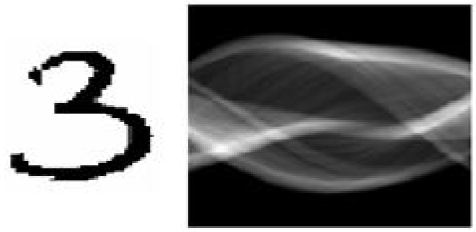

Fig 4.Sample of accumulator data of radon Transformation

Where,

$$\theta = tan^{-1}\left({}^{x_\theta}/_{y_\theta}\right), \quad x_\theta \in Z, \quad y_\theta \in Z$$

Where I(x, y) is the image function, N×N is the image size, and N is assumed to be a prime number; δ(x) is the delta function,

$$K \in \{0,1,2 \ldots \ldots N_\theta - 1\}, N_\theta = N(|x_\theta| + y_\theta)$$

x_θ and y_θ are respectively the vertical and horizontal distance with the nearest pixels.

The discrete Radon transformation is obtained as a successive columns sums, designated for the image rotated by an angle Δθ. The obtained vectors are transposed, and formed the matrix with accumulator elements (see on Fig.5).

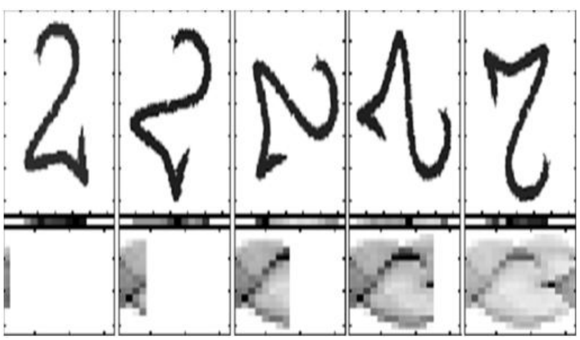

Fig. 5 Projections for 1, 45, 90, 135 and 180 degrees

III.Results And Discussion

The introduced shot boundary detection algorithm has been tested on various video data sets. we have performed many experiments on several movies, documentary , news and obtained satisfactory results. As shown in Fig 6. Is the original frame which is affected by illumination change disturbance. This disturbance is often mistaken as shot boundary. An algorithm is developed using discrete cosine transform and discrete wavelet transform, which effectively removes illumination change effect as shown in Fig. 7.

Fig 6. Original Frame

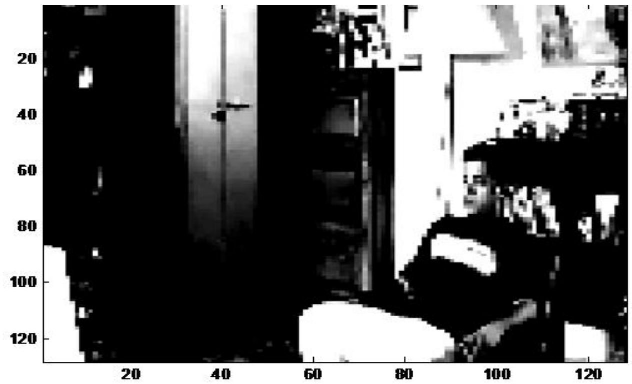

Fig 7. Frame after illumination removal

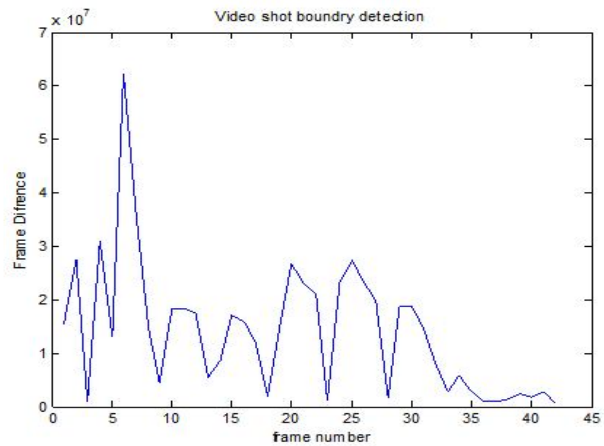

Fig.8 Shot boundary detection

In the second part we employed Radon transform as our base for detection of shot boundaries. As shown in Fig. 8 graph shows, boundary is detected between various frames. But we get highest peak between span of 5 to 10 frame number. It can be seen that shot boundary is detected between this span. To simplify we can employ adaptive thresholding technique in which highest peak above the threshold is considered for shot boundary detection. Now the radon projection of the current frame and previous frame is taken. As shown in Fig. 9 and Fig. 10. We can see difference in pattern for both the frames.

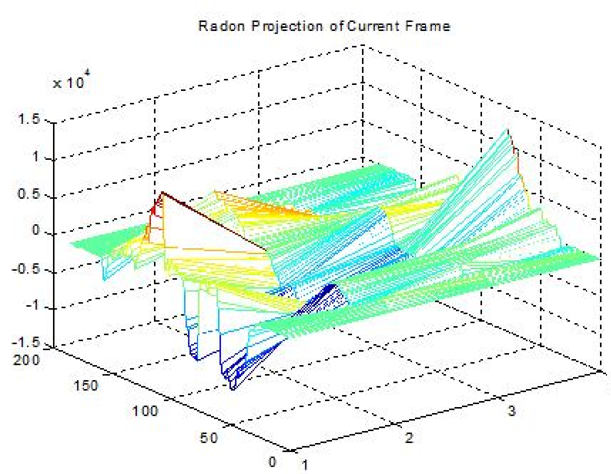

Fig 9. Radon Transformation of current frame

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In radon transformation x_t projection captures horizontal motion pattern within spatiotemporal volume and the y_t domain captures vertical pattern. Radon projection is an inherently lossy summarization of 3D volume. Extraction and quantization of local salient points is employed in projection domain.

Fig. 11 shows the frames before and after the boundary detection. We have seen the boundary detection at frame number 5. These are set of the frames form 5 to 10. Change of scene is detected after 8th frame

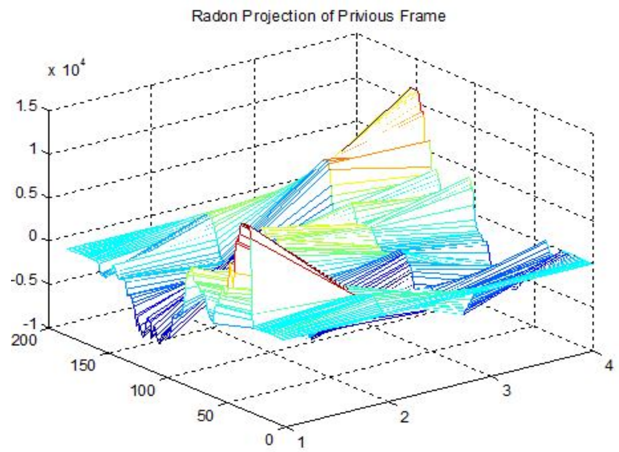

Fig 10. Radon transformation of previous frame

Fig.11 Frame before and after change in Shot Boundary

III. Conclusions

Accurate shot change detection is of great importance for organizing video contents into meaningful parts for video scene analysis. In this paper we have presented novel approach to the detection of shot boundaries. We have first removed the effect of illumination change, as often illumination disturbance is mistaken as shot boundaries. The illumination disturbance is removed using DCT and DWT. In the second part Radon projection technique is employed for shot boundary detection. Radon projection is a technique which is based on projection from different angle of salient points for extraction and quantization, which is lossy summarization of 3D volume. The results are satisfactory and encouraging. It is worth stressing some problems encountered. Camera motion, object motion and extensive content change within the shot should be considered for high performance. The method of handling these problems along with the proposed algorithm will be our future work.

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Parul Arora Bhalotra is currently working as a Assistant professor in G.H. Raisoni college of Engineering & Management Wagholi, Pune, Maharashtra, India. She is working towards her Ph .D. She receieved her M.E form P.R.E.C, Loni, Pune University. She has ten years of experience of teaching undergraduate students and post graduate students. She has published 10 research papers in esteemed International journals and more than 9 research papers in National & International Conferences. Her research interests are in the areas of image processing, image enhancement, video processing.

Dr. Bhushan Patil is currently with Samsung Research India, Banglore, India. He receieved his Ph.D. degree from the Indian Institute of Technology Bombay, Mumbai, in 2009. M.E. degree in Instrumentation engineering from Shri Guru Gobind Singhji Institute of Engineering and Technology, Nanded. He has published more than 10 research papers in esteemed International journals He has filed a Indian Patent in the area of Image compression" His primary research interests are in the area of Signal Processing, Image Processing, filter banks, and wavelets.

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